Intelligent Camera Robot

Thesis Project

A Thesis submitted to the
Dept. of Electrical & Electronic Engineering, BRAC University in partial fulfillment of the requirements for the Bachelor of Science degree in Electrical & Electronic Engineering.

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Declaration

We are the students of Electrical and Electronics Engineering Department of BRAC University representing our thesis titled "**Intelligent Camera Robot**" as requirement of completion of bachelor degree. This thesis research was performed under supervision of *Dr. Md. Khalilur Rhaman*, Associate Professor, Department of Computer Science and Engineering, BRAC University, Dhaka, Bangladesh.

This thesis is based on the results found by us. No part of this work has been submitted before partially or fully for the award of any other degree any other publication. Materials of work that found from Internet and Books were mentioned at references.

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Acknowledgments

By using robot, our life is becoming easier and comfortable day by day. With the help of android technology, we implement a robot named “Intelligent Camera Robot” which is controlled by touch sensation and human voice. This thesis work has been done for the fulfillment of Bachelor of Electrical and Electronic Engineering in BRAC University.

We will take this opportunity to express our gratitude to all those who helped and supported us throughout this thesis project. We are dedicatedly grateful and thankful to our supervisor Dr. Md. Khalilur Rhaman, Associate Professor, BRAC University to allow and encourage us to work with this project. It would not have been possible for us to complete this project without his constant encouragements, valuable insight, motivations, guideline and thanks for his belief which made us complete this project successfully.

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Abstract

Robotics has a momentous feature and future in our daily life. It can make our life fast and easier. But for real life, man and robot interaction like household or workplace creates a new question about the controlling of robot. The problem can be solved by the way the human solved it, Speech has a huge opportunity to solve this problem. Speech is the most primary mode of communication among human being so we want to create a camera which can be both voice controlled and very famous Smartphone. Well, we thought of this robot which can replace those camera man shooting videos of a film from the top with a lot of life risk. Speech recognition technology refers a robot which can recognize the voice command and act as it is programmed to do. Our Speech recognition program converts spoken words to text. Then text compared to grammar helper for its activity, if the text matches with any command with the database. It executes the command.

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Chapter 1

Introduction

1.1 Motivation:

The camera man who risk their life and get up on top of cranes to shoot the scenes of their films, they motivated us to think of a robot which can replace those cameraman. On the other hand, voice recognition is an important researched topic in the current world which is one of the most popular primary medium for communication among human beings in our everyday life. According these thought, we wanted to build a spy camera which can reach those places where is really tough to reach for human. Robots are made to make our life simple and easy so we just made a little try to make such a demo robot which can be modified further for real life applications. We have used mecanum wheels as it has ability to go through any obstacle and it can also travel on any type of surface. Now a day, Google is the heart of all Android phones and we cannot even imagine a day without Android phones. The facility of running applications in Android phones allowed us to make communication with our robot through mobile touch sensation. Arduino is the brain of our project as it has the microcontroller which has all the instructions for making this project successful. The latest technology of Android phone is Google voice which inspired us to add voice recognition feature in our robot.

1.2 Goals & Accomplishments:

Our goal was to build a robot which can be controlled through both Android mobile devices and speech recognition so that human does not have to take risk their life and rise up to heights for film making or go to dangerous places for investigation. Implementing this kind of robot including our demand is our main goal during the thesis work. According to us, it was very difficult to implement a robot which can be used in real life applications in this very short span

of time. This thesis was based on both theoretical and practical work. Though, the output of our work varied for different type of android mobile. Some mobile performed 95% successfully output and some mobile performed 80% successfully. But, some low futures android mobile performed very bad almost 50%.After average all the result, we are successful to create at least a model which performed 75% ~ 80% (average) of success rate can be further modified to save human lives.

1.3 Project Outline:

The purpose of making this robot is to take the picture at any easy & difficult place. We can control it from way of this robot. And it can go there where human face difficulties to go. The paper is organized such a way to give detailed information about to build a robot which can be controlled using particular voice command on android based mobiles. This report is divided in three major parts 1.Mechanical, 2.Electrical and3.Software. First part includes assembling the robot parts, body, mecanum wheels, electric circuit design and control the camera for taking picture. In electric part, we described about the connection among the electrical parts used in this project. Finally in software part, we discuss about the programming of android using app, arduino microcontroller and raspberry pi. Moreover, the results, limitation and discussion are also described in end of this paper.

Chapter 2

Architecture

2.1 Assembling Chassis:

The whole body of „intelligent camera robot" is made of aluminum plate. The basement part which is allocated along with mecanum wheels is parallel with ground and the distance from ground to the parallel aluminum plate is 0.4 cm. it is a very simple design consists of four DC motors and mecanum wheels, one actuator, motor drivers, screws, raspberry Pi camera, two 180 degree servos. The frame of the robot has been made in square shape and each angle is 90 degree. Motors are attached inside the frame along with mecanum wheels. Second layer of aluminum plate is screwed parallel with the first one. An actuator is bolted perpendicular on it at the middle of the aluminum plate. A sheet of aluminum plate is used to conclude the whole body structure of this robot. Two 180 degree servos and a camera attached at the top of the actuator. The camera is connected to the raspberry pi B+ to get the command of snap at different approach.

Figure 2.1: Chassis equipments.

2.2 Assembling Process:

Mainly the hardware of „Intelligent Camera Robot" comprised of three segments. This includes basement with mecunum wheel, actuator and camera. These are internally attached with each other.

The figure below shows the assembling process of parts:

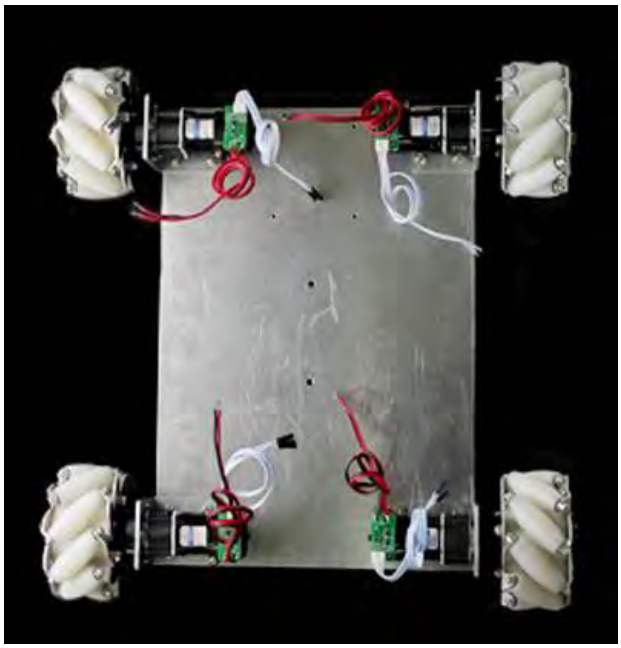


Figure 2.2: Chassis (basement) installed with motors.

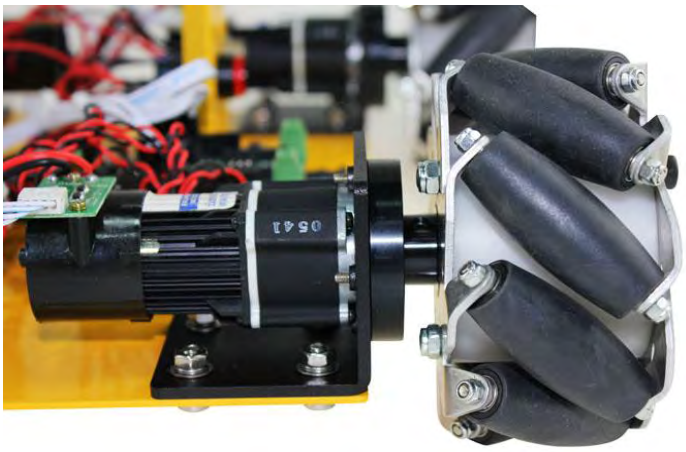


Figure 2.3: Connecting mecunum wheel with motors.

Figure 2.4: Base on chassis to support the actuator.

Figure 2.5: Inject of actuator to the base on top of chassis.

Figure 2.6: Servo motors on top of the actuator.

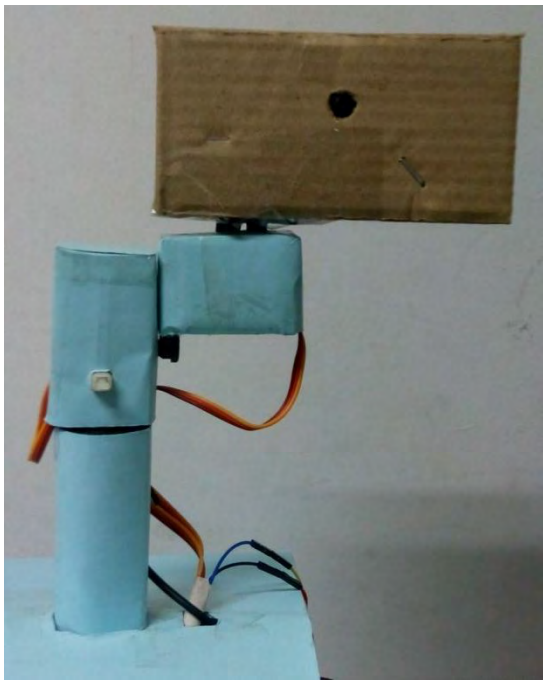


Figure 2.7: Raspberry Pi Camera mounted on the servo motors.

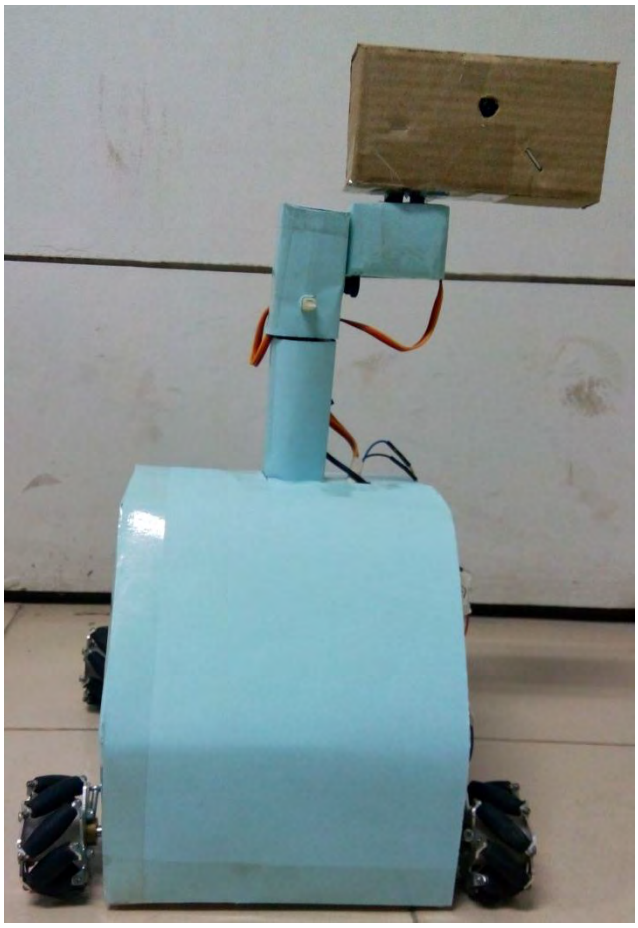


Figure 2.8: Final Project Outlook.

Chapter 3

Implementation

3.1 Introduction:

We have covered the mechanical, electrical and software part in this chapter. Mecanum wheel, actuator, raspberry pi camera and bluetooth module are some of the components which were used in mechanical and electrical part. Programming procedure of „Bluetooth Robot Controller" is described in software part. System circuit design and control implementation are also covered in this chapter.

3.2 Mechanical Implementation:

3.2.1 DC Motor:

We have used FAULHABER coreless DC-Micro motor model no. 2342l012CR in our thesis project. This dc motors was invented by Dr. Fritz Faulhaber in 1958.It is made without iron and has skew-wound rotor winding. It can provide highest power and has the best dynamic performance. It has small size and weight. Furthermore, it has smooth position and speed control with high efficiency. It has high torque due to its very low rotor inertia. [1] Motor torque can be increased by the addition of an integrated reduction gear head. This motor can move both clockwise and counterclockwise direction. It also reduces the speed to fit the specifications in the application. Four DC motors have been used to give a stable movement of the robot. [2]

Figure 3.1: DC motor.

Benefits:

- No cogging torque
- Smooth position and speed control
- High efficiency
- Low Noise
- Dynamic start-stop operation
- Low torque ripple and EMI

3.2.2 Mecanum Wheel:

The specialty of our project is the meccanum wheel. It is designed so that it can move like a vehicle in any direction. This idea come by a Swedish inventor named Bengt Ilonin 1973. For this reason, sometimes it called the Ilon wheel. The complete dynamic model of a four-Mecanum-wheeled robot considering mass eccentricity and friction uncertainty is derived using the Lagrange‟s equation then based on the dynamics model, a nonlinear stable adaptive control law is derived using the back stepping method using Lyapunov stability theory. In order to compensate for the model uncertainty, a nonlinear damping term is included in the control law, and the parameter update law with σ-modification is considered for the uncertainty estimation. Computer simulations are conducted to illustrate the suggested control approach. [3]

Its circumference has a series of rollers attached with it. Each of these rollers have an axis of rotation at 45° to the plane of the wheel and at 45° to a line through the center of the roller parallel to the axis of rotation of the wheel.[4] Moreover, the rollers enable conventional forward and backward movement as well as side by side movement and also from place rotation. It can be made to move in any direction by alternating wheels with left and right-handed rollers in such a way that each wheel applies force roughly at right angles to the wheel base diagonal on which the wheel is on and turned by varying the speed and direction of rotation of each wheel.[4]

Figure 3.2: Mecanum Wheel

Features:

- Diameter: 100mm
- Thickness: 50mm
- Material: Aluminum Alloy and Rubber
- Load Capacity: 15kg
- Roller Material: Rubber
- Roller Diameter: 29mm
- Roller Length: 47mm

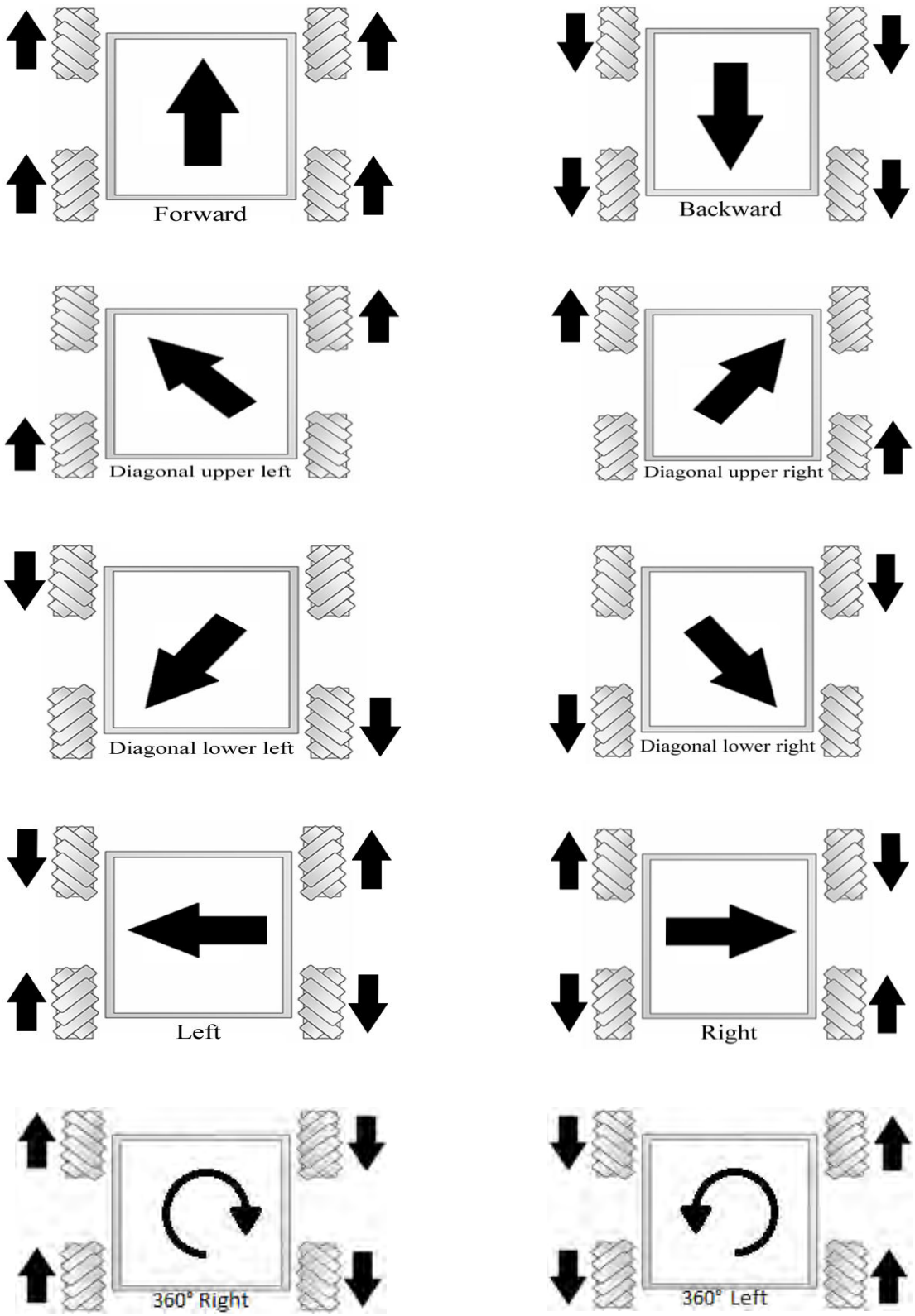


Figure 3.3: Mecanum wheel motion.

Direction of Movement	Wheel Actuation
Forward	All wheels go forward
Backward	All wheels go backward
Diagonal upper left	Wheels 2,3 forward
Diagonal upper right	Wheels 1,4 forward
Diagonal lower left	Wheels 1,4 backward
Diagonal lower right	Wheels 2,3 backward
Left	Wheels 2,3 forward; 1,4 backward
Right	Wheels 1,4 forward; 2,3 backward
360° Right	Wheels 1,3 forward; 2,4 backward
360° Left	Wheels 2,4 forward; 1,3 backward

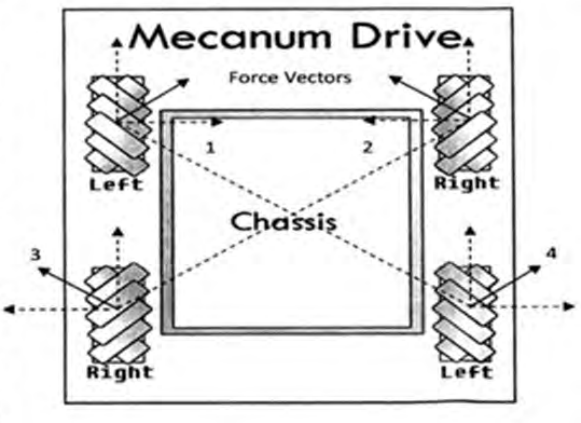


Table 2.1: Direction Chart

Pros and cons of mecanum wheel:

The advantages of the Mecanum wheel is that it is designed with passive rollers mounted around the wheel circumference at an angle of 45 degrees to the wheel plane which allows in place rotation with small ground friction and low driving torque. Furthermore, it can move in any direction without changing its position. [3]

Despite the benefit of a standard Mecanum wheel, it has an unfortunate side effect of reducing the motor effective driving force through the rollers by projecting a portion of the motor force into a force perpendicular or at an angle to that produced by the motor. Thus, it may be inefficient when the platform travels in a straight line that is especially when it travels diagonally. [3]

Limitations:

- Must use 4 mecanum wheels
- Wheels are expensive
- Requires extra gearboxes
- Challenging to program and learn to drive well

3.2.3 Raspberry Pi Camera:

We have used the Raspberry pi B+ Camera in our thesis project. The Raspberry pi B+ Camera has a fixed focus lens. It has automatic image control functions such as automatic exposure control, automatic white balance, automatic band filter, automatic 50/60 Hz luminance detection and automatic black level calibration. It also has image quality controls. The operating lens size is ¼". [5]

Figure 3.4: Raspberry Pi Camera.

Features:

- 5MP Camera
- Supports 1080p / 720p / 640x480p Video
- 25mm x 20mm x 9mm footprint
- Resolution 2592 x 1944 pixel
- Core Power: 1.5V
- Power Supply: 1.7V ~ 3.0V

3.2.4 Servo Motor:

Servo is a motor which is used accurately to control physical movement. Usually it moves to a position instead of continuously rotating. As the motor driver circuit to operate the servo motor is internally constructed into the servo so no extra motor driver is needed to operate the servo. The small motor inside the servo motor is connected through gears to an output shaft which drives a servo arm and that is also connected to a potentiometer to provide position feedback to an internal control circuit. Here, we used two servo motor which (Model-MG995) provides 180° range of rotating motion and allows controlling position. Thus, they are ideal for making something rotate over a range of 0 to 180 degrees. [6] It has been optimized for characteristics including tiny size, speed, torque, and price. Lastly, the disadvantages are that the speed and power can't be varied compared to external motors and the precision of speed control is usually not as good as with a motor shield since the servo is designed for accurate positioning rather than linear speed control.

Figure 3.5: Servo Motor.

Features:

- OperatingVoltage: 4.8~6.5 Volts
- Operating Temperature Range: -10°~50°
- Torque: 69.56/83.47 oz-in. (4.8/6.0V)
- Speed: 0.17~0.13 sec/60° (4.8/6.0V)
- Direction: Counter clockwise 1000-2000usec
- Rotation: 180°±10°

- Dual Ball Bearing
- Nylon Gears
- Weight 55 grams (without horn)
- 1x FS5106B High Torque Servo
- 1x Double Arm Horn

3.2.5 Actuator:

We have used concentric linear actuator for varying the height of the camera‟s position. On getting a small amount of voltage of 12V it moves from the fully closed to the fully open position. [7] It is easy to control over the full range of motion. The shaft will ensure its positon even when power is off.

Figure 3.6: Actuator.

Features:

- Stroke: 4 inch
- Actual stock: 3.8 inch
- Retracted length: 8.3 inch
- Weight: 1.2 kg
- Gear ratio: 20:1

- Power Voltage: 6~12V DC
- Current: 500 mA (No Load)
- Stall current: 10 A
- Speed: 0.5 in/s

3.3 Electrical Implementation:

3.3.1 Arduino:

Arduino Mega is an open-source physical computing platform based on a microcontroller board. It has SRAM and EEPROM which can be read and written with the EEPROM library. It has a 16 MHz crystal oscillator, a USB connection, an ICSP header, a power jack and a reset button. It consists of everything that is required to support the microcontroller. To start it we just have to connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila. [8]

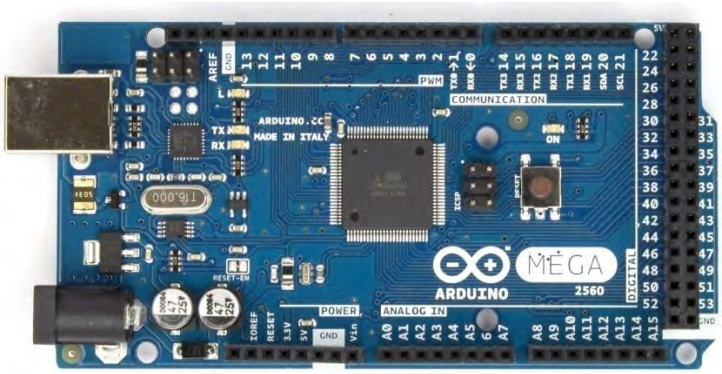


Figure 3.7: Arduino Mega.

Features:

- Microcontroller: ATmega2560
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V

- Input Voltage (limits): 6-20V
- Digital I/O Pins: 54 (of which 15 provide PWM output)
- Analog Input Pins: 16
- DC Current per I/O Pin: 40 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 256 KB of which 8 KB used by boot loader
- SRAM: 8 KB
- EEPROM: 4 KB
- CPU Speed: 16 MHz
- Dimensions: Length:101.98mm/4.01in
  Width:53.63mm/2.11in
  Height:15.29mm/0.60in
  Weight:34.9g/1.23oz

3.3.2 Raspberry Pi B+:

We have used Raspberry Pi B+ as it is the latest one with more features. At first Raspberry Pi foundation developed Raspberry Pi in UK which is one kind of minicomputer. It uses Python as the main programming language. The Raspberry Pi hardware went through many featured variations in hardware performance, memory capacity, and peripheral device support.A basic block diagram shown in figure 1.01. This block diagram interprets models A, A+, B and B+. Ethernet and USB hub components are missing in model A and A+. [9] Raspberry Pi B+ consumes the lowest power among all the other versions. It has low noise power supply so can provide better quality audio.

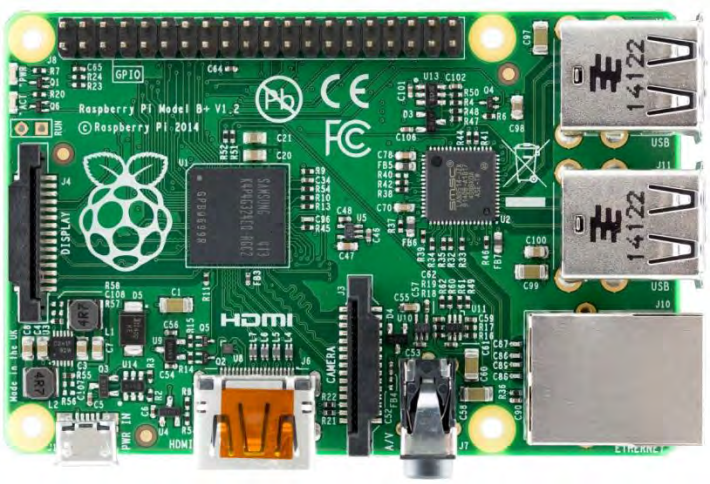


Figure 3.8: Raspberry Pi B+.

Features:

- Broadcom BCM2835 SoC Chip
- 700 MHz ARM1176J core CPU
- 512 MB SDRAM
- 4 x USB2.0 Ports with up to 1.2A output
- Expanded 40-pin GPIO Header
- Power: Micro USB socket 5V, 2A
- Camera Connector: 15-pin MIPI Camera Serial Interface (CSI-2)
- Memory Card Slot: SDIO
- USB: 4 x USB 2.0 Connector
- Dimensions: 85 x 56 x 17mm
- Power Requirements: 5V @ 600 mA via MicroUSB or GPIO Header
- Supports Debian GNU/Linux, Fedora, Arch Linux, RISC OS and More!
- GPU: Dual Core Video Core IV® Multimedia Co-Processor Provides Open GL ES 2.0, hardware-accelerated Open VG and 1080p30 H.264 high-profile decode Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure
- Operating System: Boots from Micro SD card, running a version of the Linux operating system.

- GPIO Connector: 40-pin 2.54 mm (100 mil) expansion header: 2x20 strip Providing 27 GPIO pins.

3.3.3 DC Motor Controller:

It is a dual H-bridge motor controller which is generally used in controlling motors speed and direction. An H-Bridge is a circuit that can drive a current in either polarity and be controlled by Pulse Width Modulation (PWM) as Motors will last much longer and will be more reliable if controlled through PWM. PWM is a means of controlling the duration of an electronic pulse. So, we have used two driver modules to control the four wheels. There are two enable inputs which are to enable or disable the device independently of the input signals.

Figure 3.9: L298N Motor Driver.

Features: [10]

- Driver: L298N
- Driver power supply: 5V ~ 46V
- Driver peak current: 2A

- Logic power output Vss: 5V ~ 7V (internal supply 5V)
- Logic current: 0~36mA
- Max drive power: 25W (Temperature 75 ℃)
- Working temperature: -25℃ ~ +130℃
- Dimension: 60mm*54mm
- Driver weight: ~48g
- Super driver capacity
- 4 pull up resistor switch
- 2 DC motor & 4 coil dual phase motor output

3.3.4 Bluetooth Communication:

HC-05 is the latest Bluetooth wireless serial cable. We have used Bluetooth HC-05 for communication between our Arduino Mega and our android phone which has the Bluetooth robot controller software installed on it. It has two working modes. The two working modes are order-response work mode and automatic connection work mode. User can send the AT command to the module to set the control parameters and send control order when it is at the order-response work mode. There are three work roles in the automatic connection work mode which are Master, Slave and Loopback. It will follow the default way set lastly to transmit the data automatically when the module is at the automatic connection work mode[1]. We are using the automatic connection work mode and the master and slave mode can be switched. Therefore, for our case Arduino Mega is the master and the Android phone is the slave. We have used 9600 as the default communication baud rate and the password for connection set up is 1234. In our Bluetooth hc-05 we have kept the stat and En pin ideal. The current fluctuates from 30-40 mA range while pairing and the mean current flow is 25mA. Lastly, after connection is established 8mA a current flow no matter communication is processing or not. [11]

Figure 3.10: Bluetooth module (HC-05).

Features:

- Bluetooth protocol: Bluetooth Specification v2.0+EDR
- Frequency: 2.4GHz ISM band
- Speed: Asynchronous: 2.1Mbps(Max) / 160 kbps, Synchronous: 1Mbps/1Mbps
- Security: Authentication and encryption
- Operating Power: +3.3~5V DC 50mA
- Working temperature: -20 ~ +75 Centigrade
- Dimension: 26.9mm x 13mm x 2.2 mm
- Output power Class II
- Flash 8Mbit
- Default Baud rate: 38400
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.
- Auto-reconnect in 30 min when disconnected as a result of beyond the range of connection.
- Auto-connect the last device on power as default.
- When master and slave are paired, red led blinks 1time/2s in interval,
- Auto pairing PINCODE:"1234" as default.

Cautions:

- Be paired must Master devices and Slave devices each other.
- Do not over 6 voltage

3.3.5 6V Relay Breakout Board:

6V relay breakout board with a single relay and all necessary pin outs and connectors. It has one 10K resistor, one BJT and a relay. It has a P2N2222A amplifier transistor which is NPN Silicon.

Figure 3.11: 6V relay breakout board.

Features:

- Output Voltage: 6V
- Maximum Input Voltage: 14V
- Current Rating: 1A

3.4 System Circuit Design:

Hardware parts which have been used for this project are able to communicate by this circuit design. Bluetooth module, Arduino, Motor drivers, Motors, Servo motors, Actuator, Raspberry Pi & Raspberry Pi Camera is connected together in this circuit.

Receiver pin (RX) and transmitter pin (TX) of Bluetooth is connected to arduino pin TX0→1 and RX0←0 accordingly as those pins have been defined as serial port with jumper wire. Pin 3, 4, 5 and 6 are connected to motor diver 1 where motor 1 and motor 3 are connected with driver 1. Similarly pin 7, 8, 9 and 10 are connected to motor diver 2 where motor 2 and motor 4 are connected with driver 2. Pin 11 and 12 are connected with servo 1 and servo 2 which are the control pins of the servos. Pin 1, 2, 3 and 4 from driver 3 is connected to Arduino pin 22 and 23 accordingly for actuator. The 24 pin of arduino mega is connected to GPIO 17 of Raspberry Pi B+ to capture pictures because the camera is connected with the Raspberry. Power pin of Bluetooth module, Motor drivers and Servo motors are connected to Vin pin Arduino and the ground pin is connected to the Arduino ground pin. Raspberry Pi will be powered with 5V power source but all the ground will be connected.

All the connections are made with the wires from the breadboard to Arduino and Raspbarry Pi.

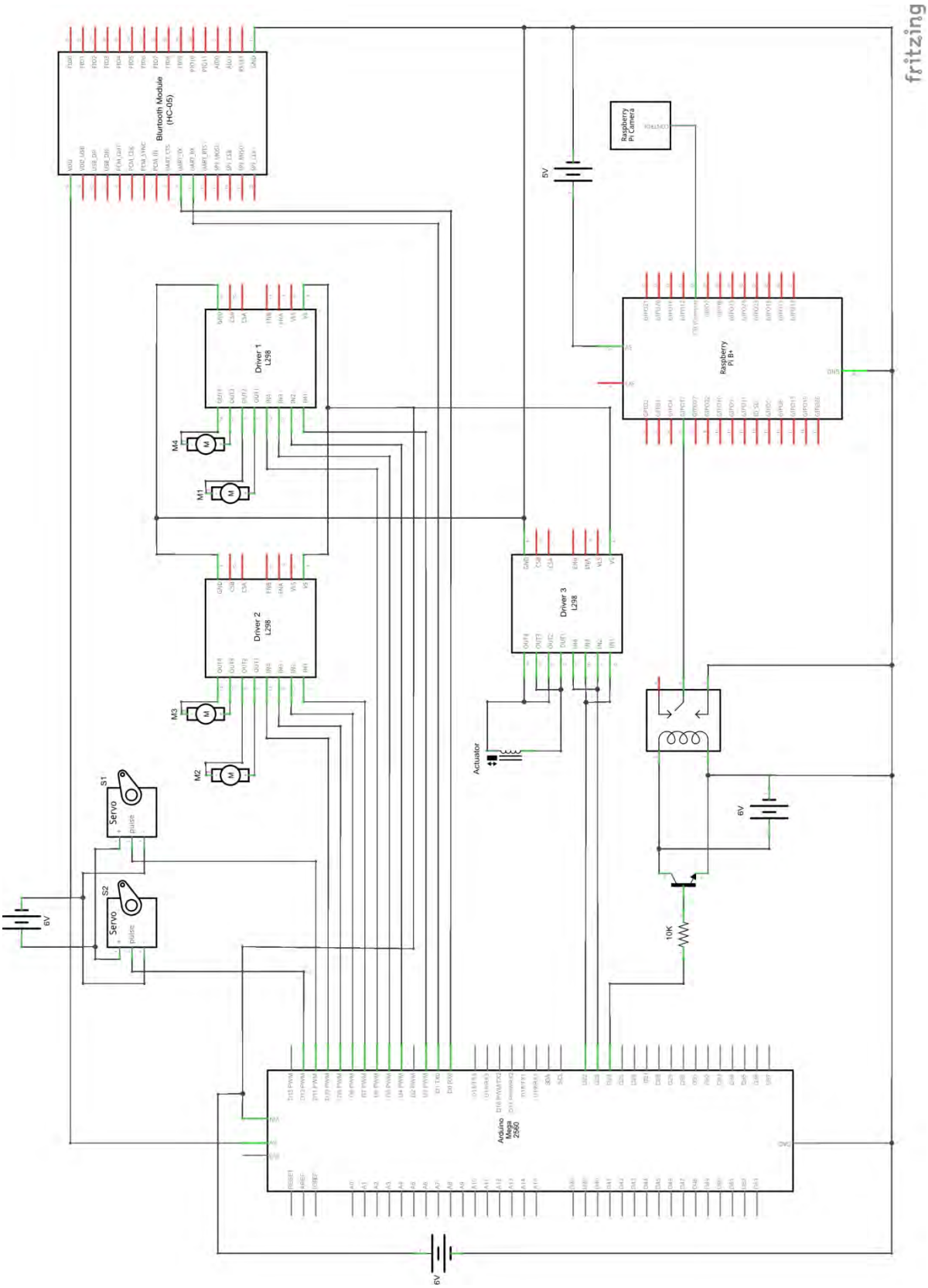


Figure 3.12: System Circuit Schematic.

3.5 Software Design:

3.5.1 Arduino Software:

Arduino software can program Arduino board. Windows, Mac OSX and Linux are different platforms for Arduino software. It is open source software and java environment has been used to design it. Users can write their code in C and upload to the board by using the Arduino Software. As the boot loader allows the uploading without the need of external hardware programmer, the software is very efficient and easy to use.

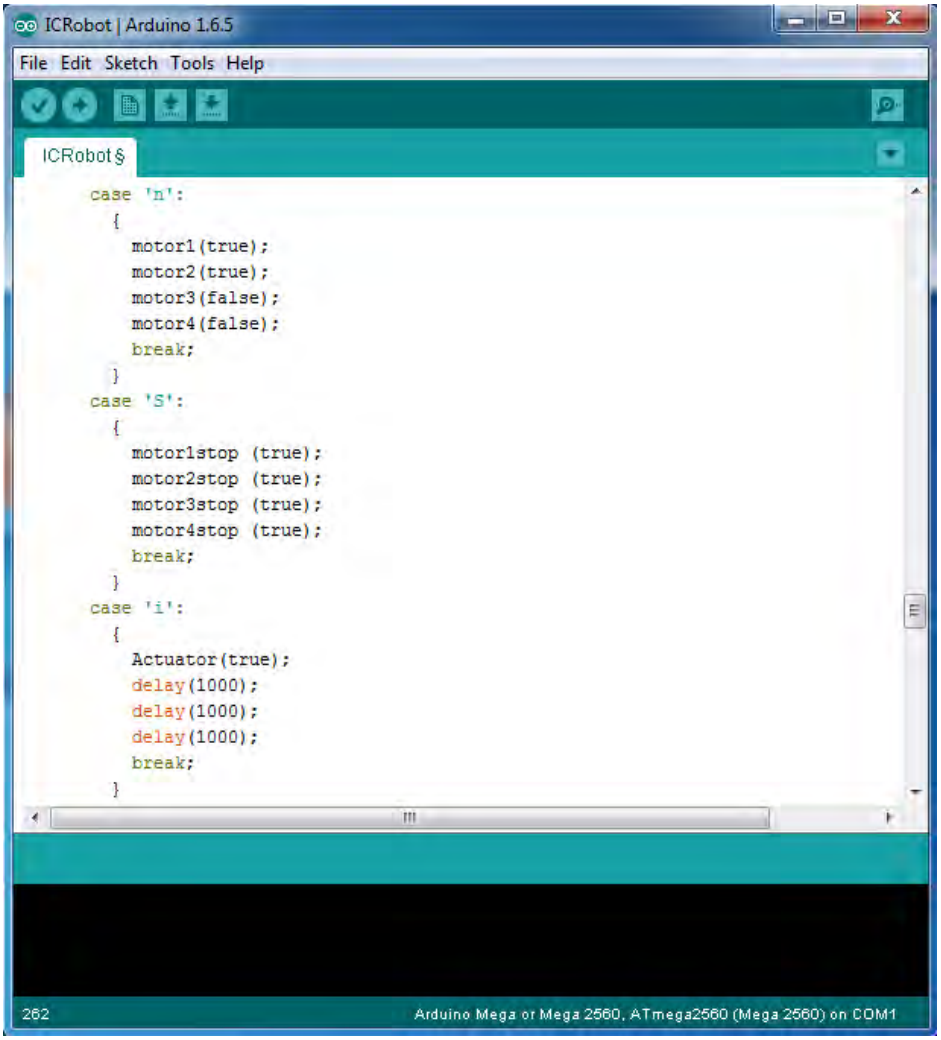


Figure 3.13: Arduino Software.

3.5.2 Raspberry Pi Software:

Camera Pi module, a quality photo video camera purposely designed for Raspberry Pi, which is designed to recognize colors and shapes. Camera Pi is an excellent add-on for Raspberry, to take pictures, with the possibility to apply a considerable range of configurations and effects. A framework named OPENCV can be used on LINUX, Mac OS X. This library has been designed mainly for processing images in real time. To connect the modem a USB mode switcher is installed which is the first step towards WVdial to run APN, AT command.

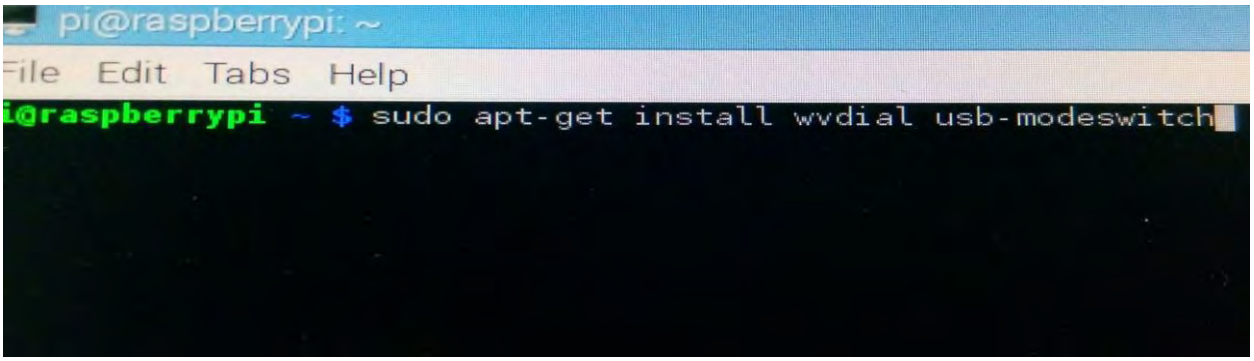


Figure 3.14: WV dial script.

Cronn job is being used for script which is based on linux curnel. Lunch script been kept into it. USB will get the connection within 30 seconds.

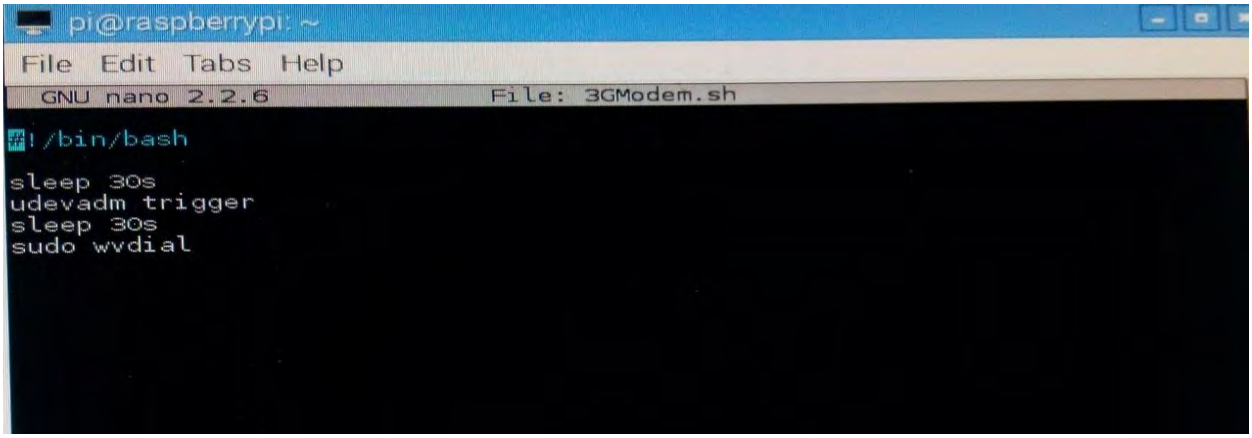


Figure 3.15: Connection establishment.

Dropbox with Raspberry Pi:

To upload photos from ours raspberry Pi camcorder straight to dropbox , a dropbox account is formed. A dropbox uploader is installed in raspberry Pi.

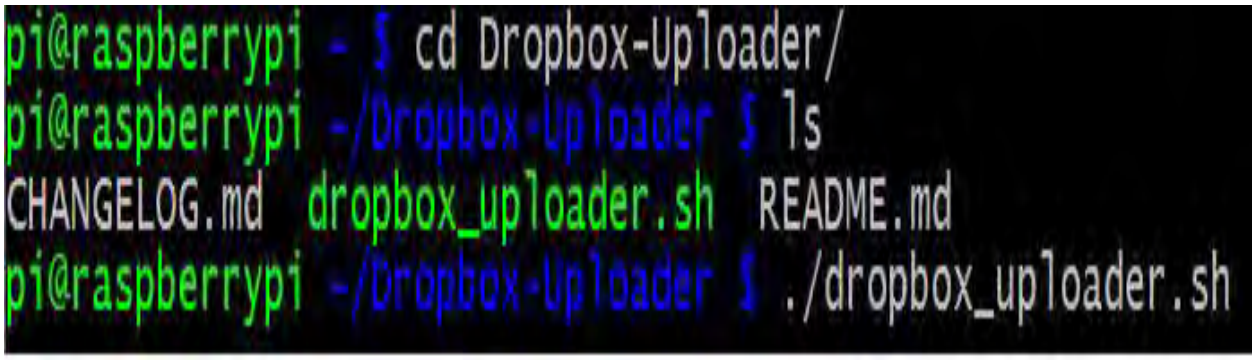


Figure 3.16: Dropbox Uploader.

Then "Dropbox API app" been created. After all this authorization is token and a web URL is given. Basically it is a bash script using curl which means, there is nothing to install. It can be called from python script and work properly .in case of restart processor will get the beat of every 10 seconds. [12]

3.5.3 Android App Design:

The connection between the Bluetooth HC-05 and Android mobile phone is made using our „Bluetooth Robot Controller" Application. The Bluetooth network stack which allows a device to wirelessly exchange data with other Bluetooth devices is a special feature of the Android platform. The Android Bluetooth APIs allows the application framework access the Bluetooth functionality. Wireless Bluetooth connection with other devices is only possible because of these APIs which enables point-to-point and multipoint wireless features. We have used socket programming for Bluetooth socket connection.

Before establishing socket connection a universal unique identifier was defined for our application named „Bluetooth Robot Controller" which extracts all the list of paired devices. The android bluetooth package contains all the available Bluetooth APIs. The entry-point for all Bluetooth interaction is the Bluetooth Adapter. It helps to discover other Bluetooth devices and query the list of paired device using a known MAC address and create a Bluetooth Server Socket for establishing communications from other devices. Bluetooth Device is used to request a connection with a remote device through a Bluetooth Socket or query information about the device. Bluetooth socket which is similar to a TCP socket is the connection point that allows an application to exchange data with another Bluetooth device through Input Stream and Output Stream. Bluetooth Server Socket represents an open server socket which waits for incoming requests. Thus, when the HC-05 is selected from the list of available Bluetooth devices the socket connection opens. Hence, when a remote Bluetooth device of Android phone makes a connection request to the HC-05, the Bluetooth Server Socket will return Bluetooth Socket when the connection is accepted that is it will basically send an acknowledgement without sending any data thus we can see in our mobile that the Bluetooth is connected.

The entire coding is done in Android Studio which is a development tool for coding. Android Studio is the official IDE for Android application development, based on Intelligent IDEA. Android Studio offers flexible Gradle-based build system, build variants and multiple apk file generation, Code templates to help build common app features, rich layout editor with support for drag and drop theme editing, built-in support for Google Cloud Platform. Above all, Google Android Studio uses java as its language which is the easiest language for coding. Each individual button in the application represents a character and here each button means an event fire in java. When a button is pressed an individual character is send by an object named out stream in java under which instructions are defined which makes the robot go for action.

Now, for voice recognition Google voice assistant was called which captures our voice stream and then it checks the voice string sent from the Google language package and compares them to decide what action should be carried out by our robot. Moreover, if the Android phone is a latest version which has Google language package installed built in then the robot can be operated offline that is without any internet connection otherwise we will need internet connection for

voice communication. The Android minimum version for our application is 2.3.0. Our application just sends stream for communication so faster data communication is possible without any effect on RAM.

Lastly, the Google drive section of our application has a browser. The browser we use in our mobile is saved here in this application using web view class in Android Studio. This class is the basis upon which we can roll our own web browser or load a remote URL. URL is a universal resource locator which can be typed in the text box of the browser. Once we type the Dropbox link in the url text box the pictures we took with our camera starts loading and we can view them through this application but internet connectivity is must for picture viewing. We also kept a refresh button which when clicked refreshes the web view.

To create an application we must have to select the target versions of android mobile. Where the process of making an app is started.

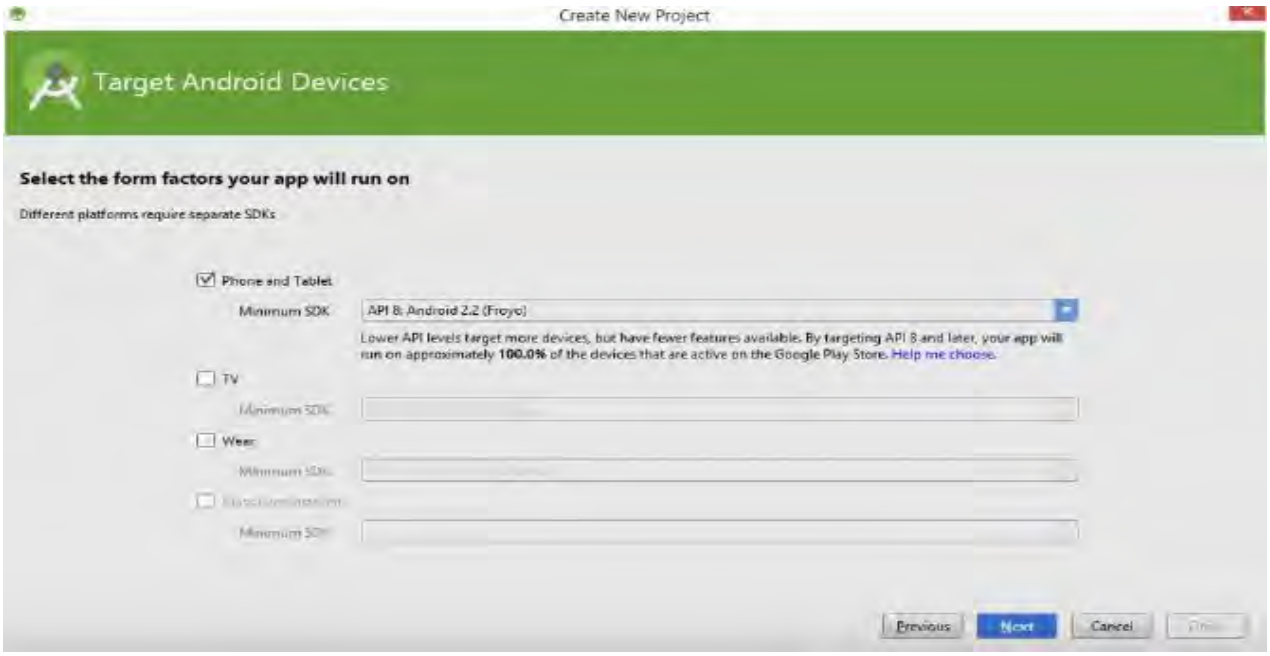


Figure 3.17: Fundamental structure of ICR app.

After creating the white background, by using widget the button position got selected which is using in sending a particular string to the Bluetooth device. Widget also used to create the size of the text (if button needed to show the text). Properties were used to create the layout of ICR app.

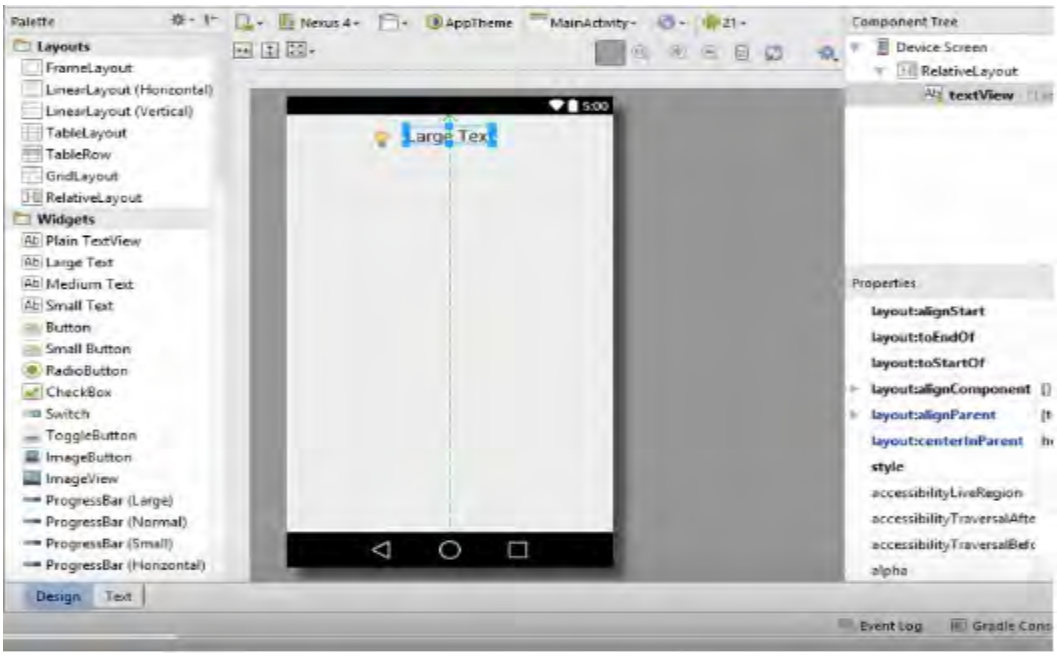
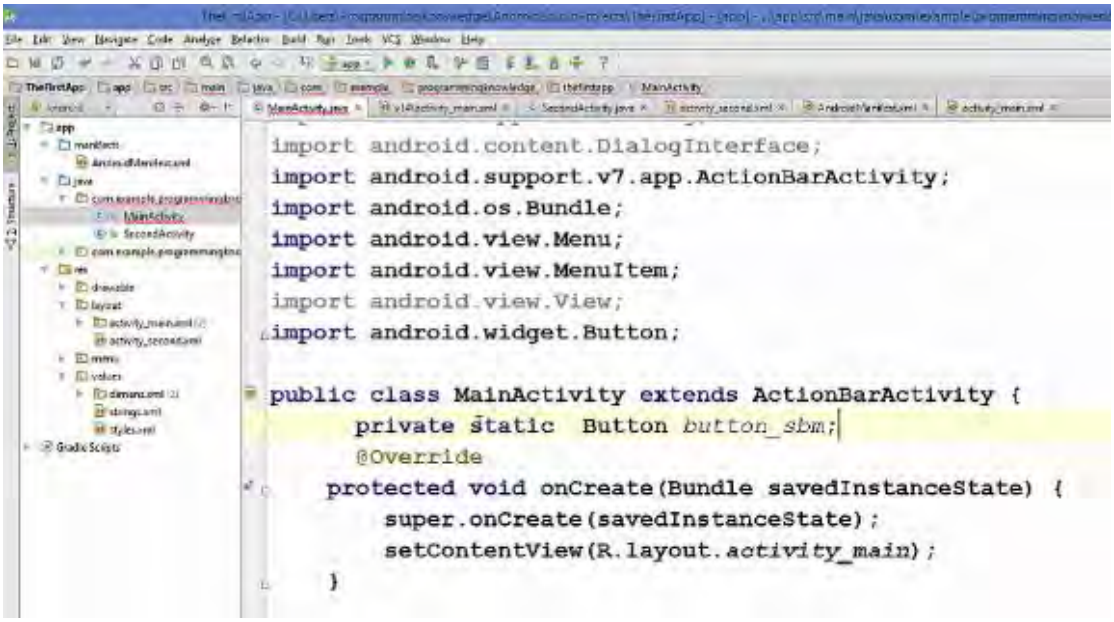


Figure 3.18: Button placement of app.

After creating the actual layout (keypad, speech, and drive) now we have cast all the touch buttons under the main activity to submit a string to the Bluetooth device.



```
import android.content.DialogInterface;
import android.support.v7.app.ActionBarActivity;
import android.os.Bundle;
import android.view.Menu;
import android.view.MenuItem;
import android.view.View;
import android.widget.Button;

public class MainActivity extends ActionBarActivity {
      private static  Button button_sbm;
      @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
    }
```

Figure 3.19: Button placing code.

3.6 Control Implementation:

„Bluetooth Robot Controller" is the android application which has been made for this thesis project to control the robot which main aim is to take pictures of various places by doing movement. This app is very simple to use which has three tabs. One tab is for controlling the movement; another one tab is for taking pictures and rotating the servos & the last one is for viewing the taken pictures. Also this robot can go over through any kind of obstacle.

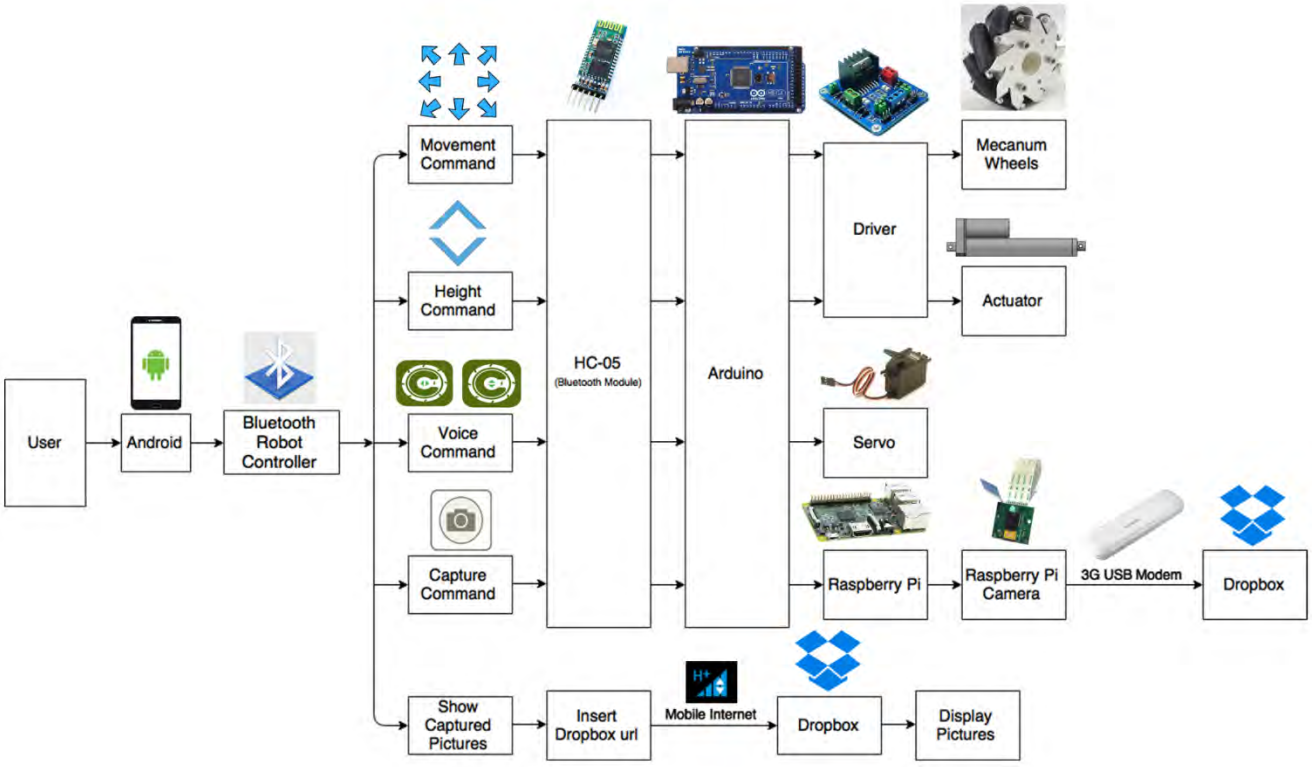


Figure 3.20: Block diagram of control system.

When you open the Bluetooth Robot Controller application from an Android device; the Bluetooth of that device opens automatically. After that a list of your paired Bluetooth devices will pop up with a header name written as „Select Your Device". From here the connection can be done with the desired paired Bluetooth device. But if the desired Bluetooth device is not paired with the mobile then the pairing between the mobile and the Bluetooth device must have to be done manually from the Bluetooth setup option of the mobile. As we use HC-05 for the connection which is installed in arduino on the robot, so we will tap that name. After taping the

name we will see connecting box. After the connection has been completed the soft transparent ash color background will be gone and will show the movement button.

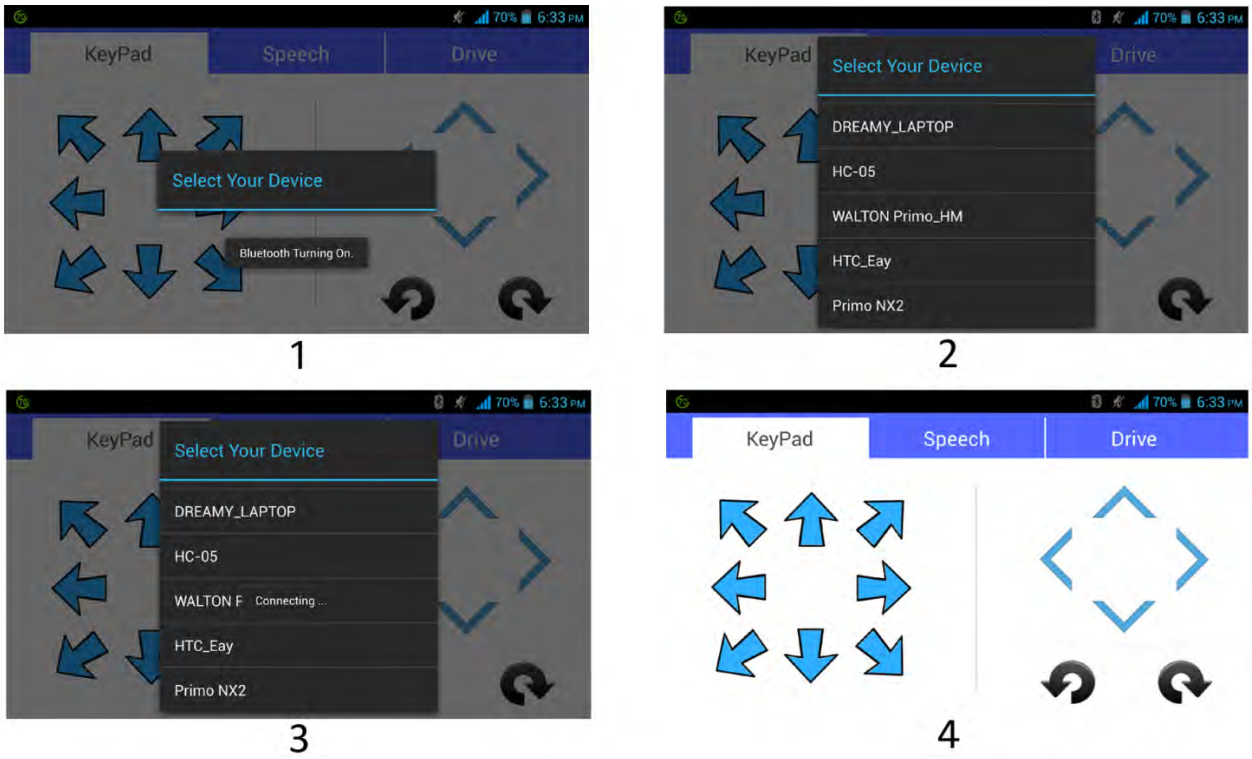


Figure 3.21: Connection with Bluetooth module.

When the movement button can be seen that means its connection is completed and it was successful. Now from the KeyPad tab we can move and select the height of actuator by tapping on the icon. Each icon has individual string. When any button has been pressed by the user; on that time a fixed string is generated. This string goes to arduino through Bluetooth module. Then the arduino will run its code and will understand the meaning and do rest of the work. The strings for movement and height is from „a" to „n". Example, if the forward movement button has been pressed then string „a" will be generated. Same for 360 degree rotation (right side), it is „n".

Speech tab contains the capture and the servo buttons. Capture button"s function is same as before. Its string is „0". But servos work differently. When the servo"s buttons are pressed, it activates the Google speech and users are asked to give command which will give rotation direction for servos. There are four commands to control the angle of the camera using servos.

For servo 1 which are „Right“ and „Left“. And for servo 2 which are „Down“ and „Up“. When a command is given it goes to the Google language pack through Google speech. Then it scans the voice frequency and finds the word. After finding the word it determines whether this word is applicable for this application or not. If it is applicable then generate the corresponding string and follows the previous way to connect arduino and do the work. The strings are „p“,“q“,“r“ &„s“ for the servo voice command.

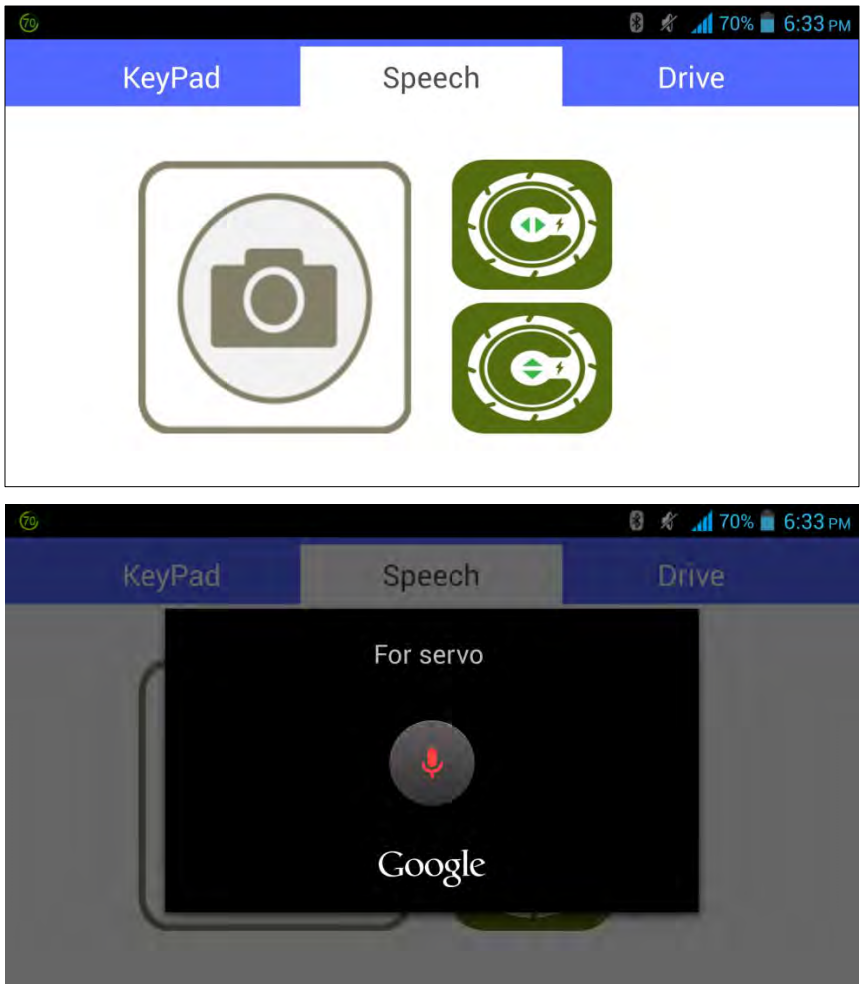


Figure 3.22: Capture and Speech Function.

At last the Drive tab is in the „Bluetooth Robot Controller“ application. Here a url box is shown. We have to put the fixed Dropbox url address in the box where the photos had been stored. After giving the url, mobile will access the Dropbox folder and show the picture in the Drive tab. The

picture what we had taken last will show at first. If we tap in the picture it will show in bigger size.

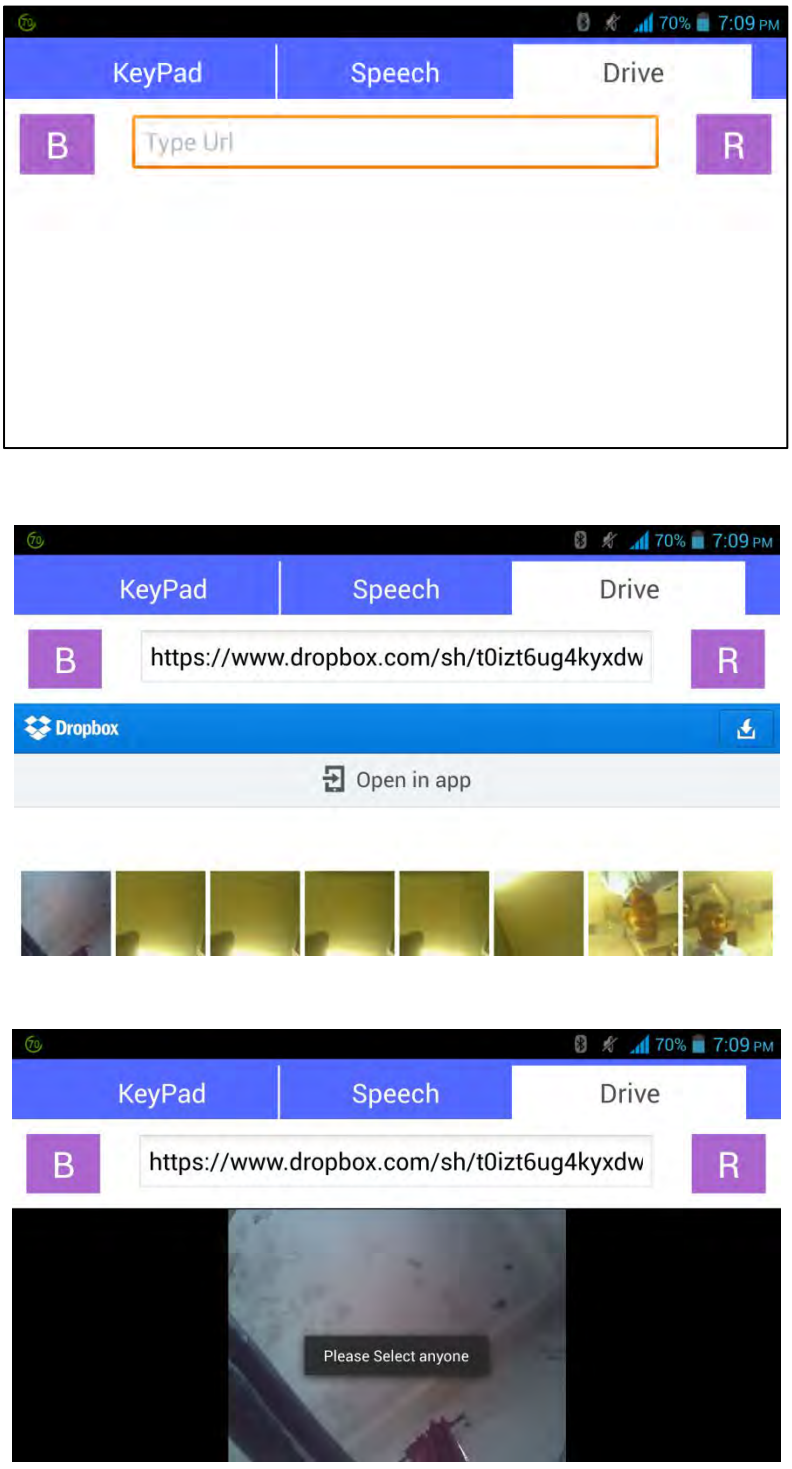


Figure 3.23: Display Pictures Functions.

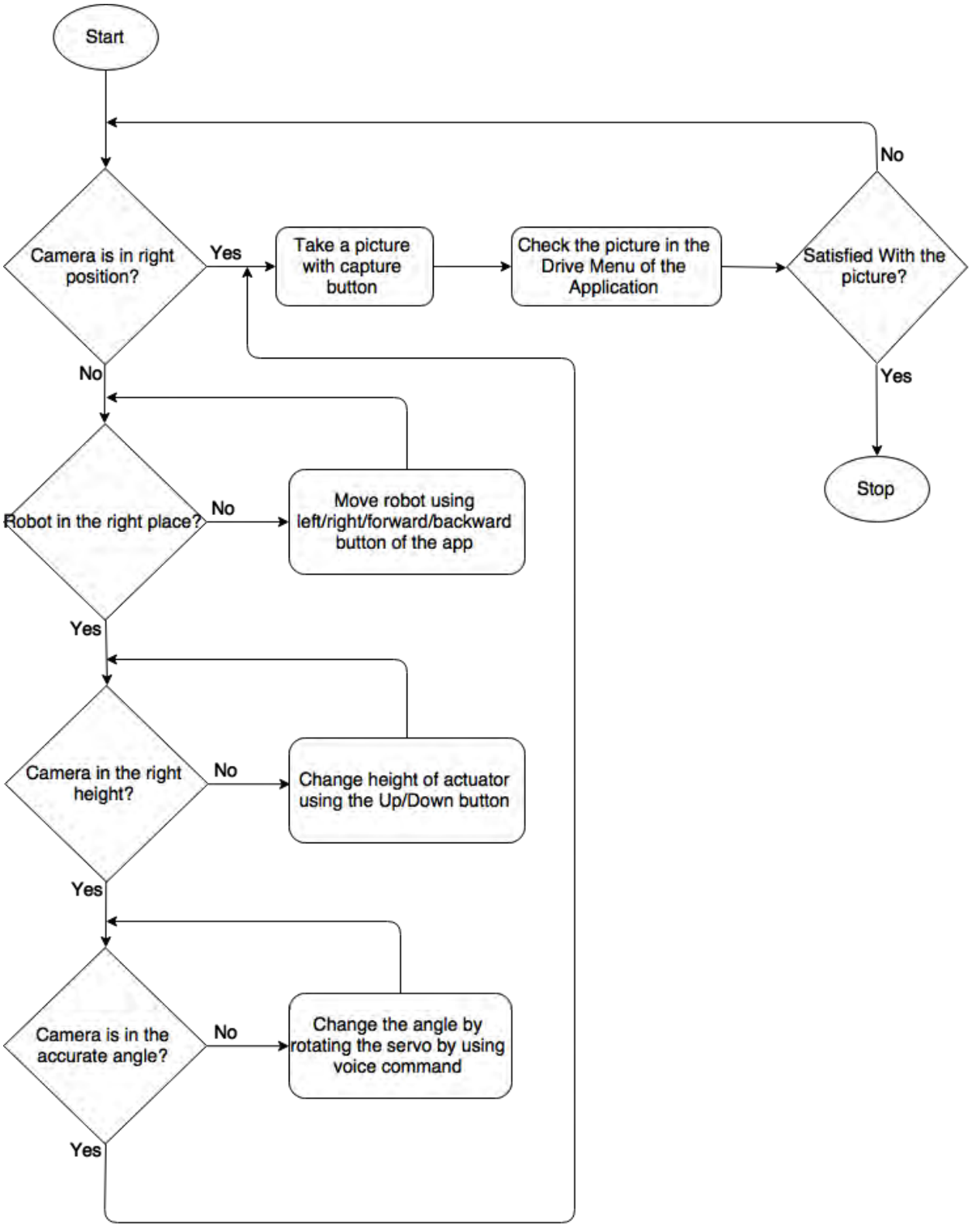


Chart 3.1: Control flow diagram.

Chapter 4

Experimental Result

To increase the performance and accuracy of the robot several experiments were conducted. These made robot mechanism smooth. First we test the accuracy of android Google speech. We managed android mobile of various brand. We also managed various android versions of the brands. We had selected few male and female who can take English in both Asian and US accent. We did all this to find the accuracy of the voice command of our app. Initially by using HTC and speaking US Female accent we had 92% of accuracy. This was the highest accuracy at first. Then by experimenting we found that we can have 96% of accuracy in the voice command if a male speak in Asian accent and use HTC mobile.

We found on the experiment that performance of HTC is the best. It has almost no delay and it can also detect voice in the noise. But the voice detection ability of Symphony was so poor. It can‟t detect voice in a noise less room. We also noticed that the performance of „Bluetooth Robot Controller‟ is higher in the higher and latest version of android. For Samsung mobile we found a specific problem. Samsung mobile which support or has S-Voice, couldn‟t run our voice command part of the app. Because the mobile can‟t find the Google speech. But if we install Google voice apps and download language pack then the mobile can run the voice command.

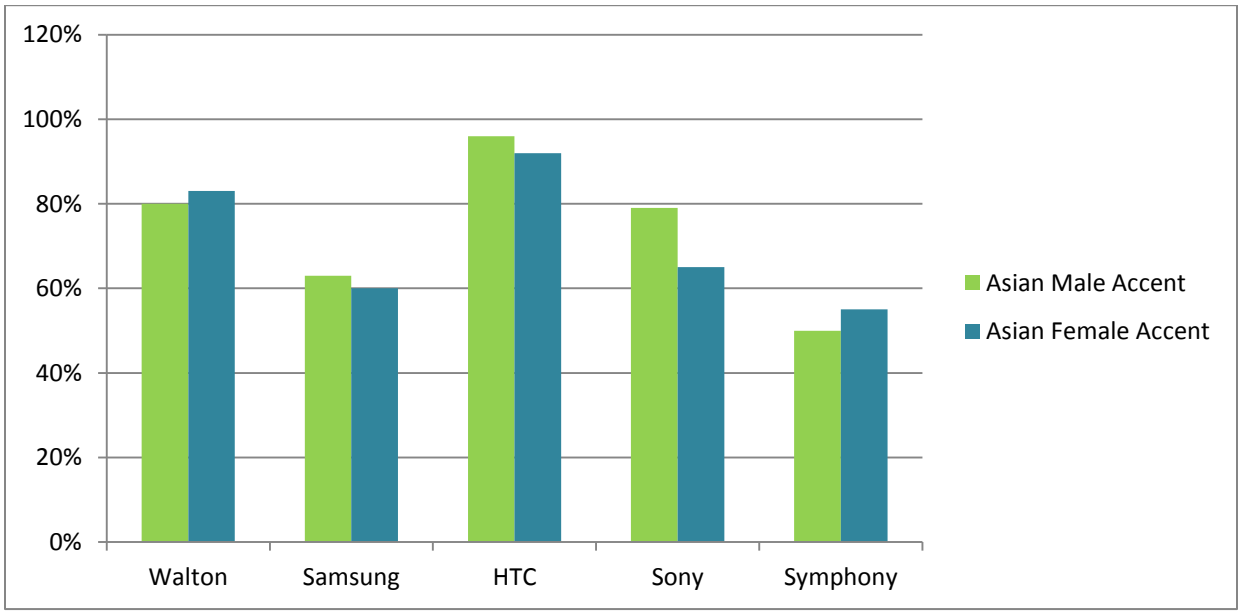


Chart 4.1: Performance of accuracy for Asian accent.

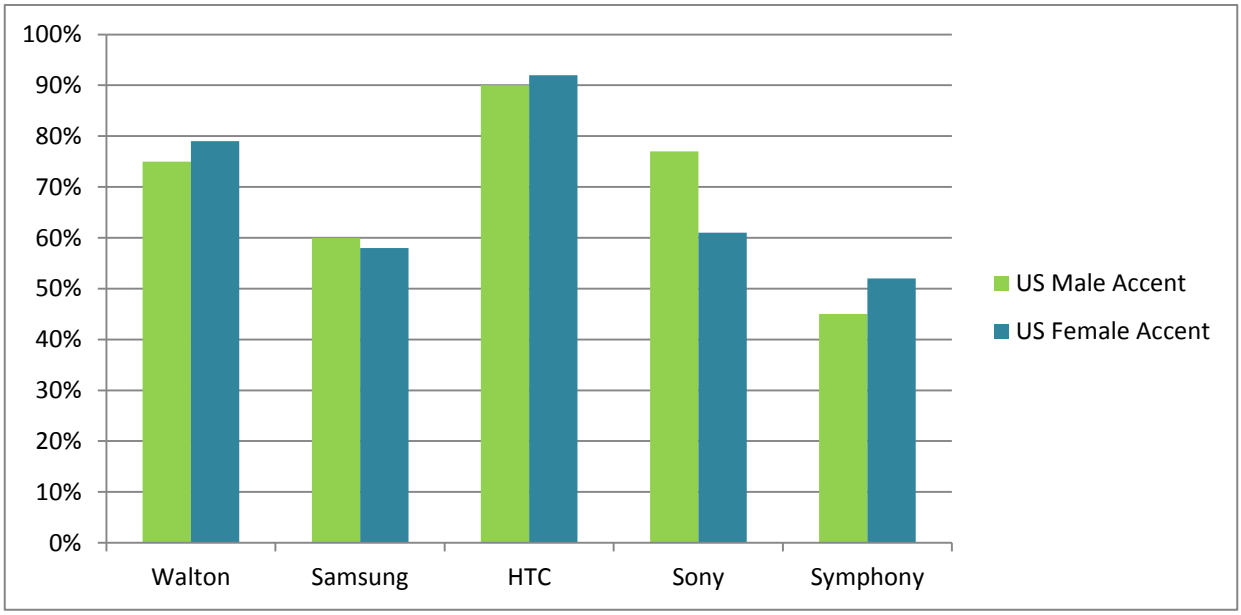


Chart 4.2: Performance of accuracy for US accent.

Secondly, we did lots of experiments on actuator with/without load. And we found vary in the current and the speed of actuator. Those can be representing by the following way.

Push/Pull Max. (N)	Speed (mm/s)		Current (A)	
	No load	Full load	No load (12V)	Full load (12V)
600	6	3.4	0.4	1.2

Table 4.1: Actuator experiments value.

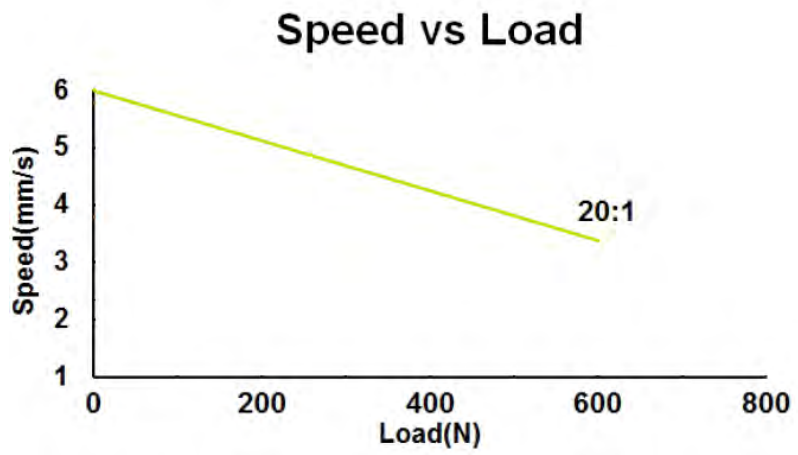


Chart 4.3: Speed Vs Load of actuator.

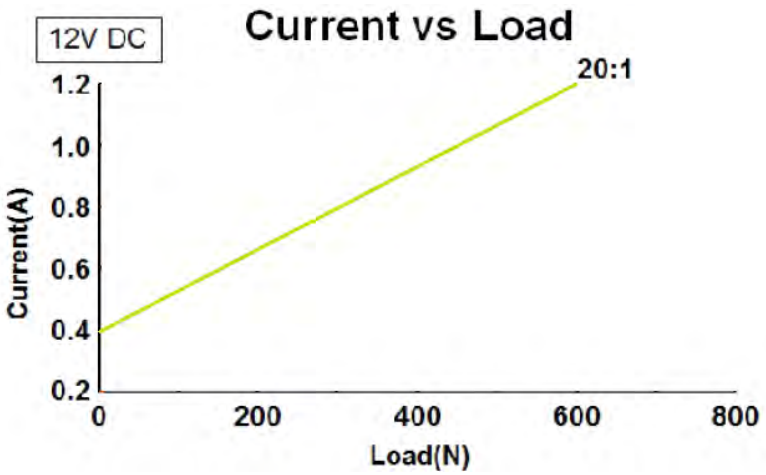


Chart 4.4: Current Vs Load of actuator.

Next, we also measure the elements of Raspberry Pi Camera. Like Lance length. Length of the RPi camera wire. Diameter of the holes etc.

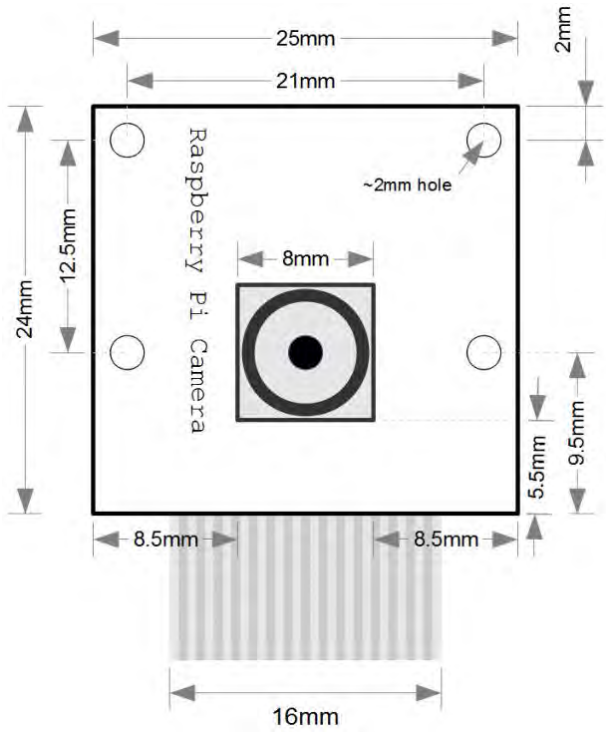


Figure 4.1: RPi Camera measurement.

Finally, we did various experiments on mecanum wheels. Here we have applied 3V to wheel. Thus, we have measured the distance covered by the mecanum each 5 seconds.

Time (s)	Distance (m)
5	0.75
10	1.45
15	2.30
20	3.00
25	3.50
30	4.38

Table 4.2: Mecanum wheel experiment value.

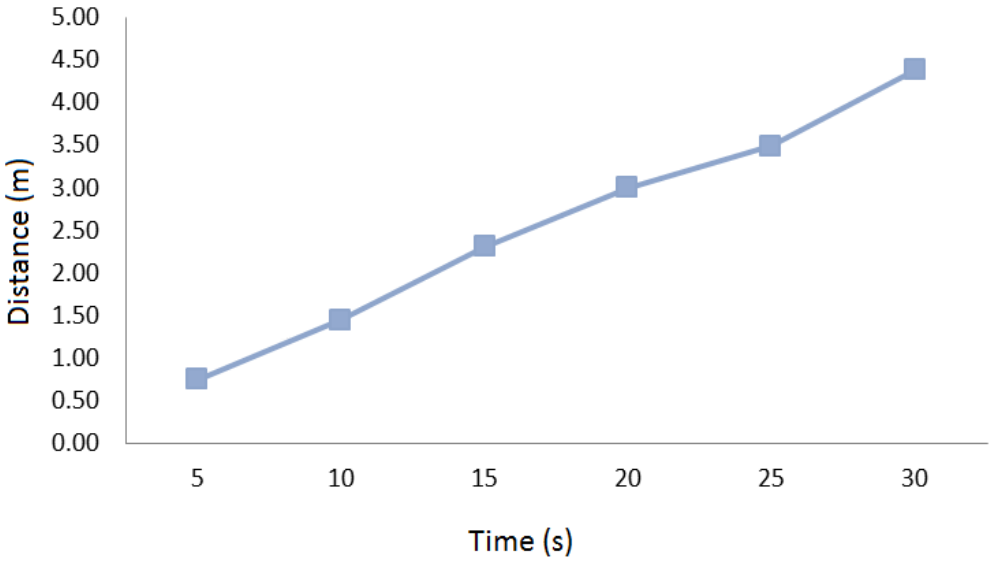


Chart 4.5: Time Vs. Distance of mecanum wheel.

Chapter 5

Conclusion

Robot is a very important element of present development which will lead us to the fast and easy life what we all are dreaming. For that reason now a days it is essential to interact with robot and make happen what we want to be done by them. This human-robot interaction part is very challenging area. Controlling robot and take pictures from remote distance is very simple but very beneficial to some specific persons like director, spy, firefighter etc. This robot can take pictures where human can‟t go or survive.

The main target of this project is to build a robot which can take both touch and voice command and can take pictures of remote and unreachable area where it is impossible for human to go. Also can overcome any kind of road blockage. This is a prototype of our main target. As android device is very popular and easily available to anybody, we make an android application to interface with the „Intelligent Camera Robot‟. We have gained lots of experience during this project. We also found some limitations in the project. It has a huge future scope if we can overcome the limitations and can implement the ideas what we gained during the project.

5.1 Limitation:

We managed to complete our goal successfully though it has some limitations. So, we managed to note down our limitations in this project. Firstly, the chassis is very close to the ground so the meccanum wheels which has ability to overcome obstacles is unable to pass through barrier rather it gets stuck. Then actuator can move very fast if higher voltage is provided but we can only provide 3V from arduino so it moves slowly. Also, actuator cannot be stopped at any

desired middle position. It can only be stopped in the maximum or minimum height. Angle deviation error in servo is another problem. So we can rotate servo only is 180º.

For raspberry pi, it takes one minute for establishing modem connection. We have to wait 55 seconds for picture upload due to slow internet connection of GP SIM. Then, no display to view the live streaming of camera. So we can‟t see what we will capture before taking the pictures. Lastly, application has to be connected with HC-05 frequently and it takes time to pair up.

5.2 Future Scope:

Lots of scopes are there to increase the efficiency of „Intelligent Camera Robot‟. Firstly, Overcome obstacles can be regained by increasing the chassis and the ground. One of the ways to do this is by using meccanum wheels which have bigger diameter. Another way is by giving more voltage to DC motors of meccanum wheels. Then, faster height change can be done if 12V can be provided to the actuator. Maximum and minimum height is available for the actuator. Multiple stoppages can be made between the highest and lowest height to have various height for the camera. We can have more accurate picture around 360 degree ranges by increasing the division amount of servo angle. Mechanism can be faster and more efficient by only using raspberry pi for controlling everything.

GPRS modem can be changed by Wimax. If we do raspberry pi code for this then picture upload delaying time can be reduced. We can improve the app in such a way that the voice commands can also be recognised by the S Voice of Samsung mobile. Replacing the pi camera by USB web camera, we can have high resolution picture quality. Adding live video streaming in the application is one of the main and important sides what can be developed. So that we can see the view which camera can capture on that moment. Actually it will help us to see what we are going to capture. If the camera focus is not in the right position, it will also help us to adjust the focus of camera what we desire for to capture.

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